Lecture 17:
Professional and Social Context of Engineering Design

Outline:
- Engineering, Technology and Society
- Professionalism
- Engineering Ethics
Engineering, Technology and Society

It is important to understand the role of engineering within our society.

Consider some general definitions of Technology:
- “The study/application of some art/skill/craft”
- “Technology is the usage and knowledge of tools, techniques, crafts, systems or methods of organization in order to solve a problem or serve some purpose.” [Wikipedia]

Consider some general definitions of Society:
- “The totality of social relationships among organized groups of human beings.” [Collins English Dictionary]
- “A group of humans broadly distinguished from other groups by mutual interests, participation in characteristic relationships, distinct cultural patterns, shared institutions, and a common cultural identity.”

In your opinion, what are some of the greatest/most significant/most important technologies developed by humans:

Some examples of Modern Technologies:

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Society as we know it, cannot function without technology. It is integral to our lives, and fundamental to our existence.

As a society, we often take technology for granted. However, we must always be aware of its values, and shortcomings.

Engineers are the members of society that are engaged in “systematic development of technology, and application of that technology to the benefit of society.”

It is a critically important responsibility that engineers have.

Your engineering activities can have profound impact on society.

Hence, you must become knowledgeable on how society is organized, how it functions, and how it uses/depends on technology.

Your previous course, ENGR 297, has introduced you briefly to some of these concepts, and others.
Technology can be created by anyone. However, engineering is a profession that specifically trains you the practice of developing technology and applying it.

An Engineer involved in Design, is a professional, formally educated “Technology Maker/Creator”.

As a Design Engineer, you have tremendous power and responsibility. Your technology (i.e. product, process, technique, etc.) has the ability change the way people live (i.e. do things, behave, interact, etc...) and can have huge ripple effects throughout society.

Examples:

In this course, we have studied “Engineering Design”.

You must strive to consider/implement/integrate the concepts of ENGR 297, (i.e. impact on society, culture, etc...), into your design process.

This can be done by adding/including such concepts at the following stages of the design process:
- Goal Statements
- Objectives/Constraints
- Selection Method for Concepts

AND, by documenting/discussing the implications to society, during the final report/communication/presentation stage of the design process, for your stakeholders.
Professionalism in Engineering

Engineers are “Professionals”, but what does this mean?

Characteristics of any Profession:

- Work involves exercising skills, judgement, and discretion, which is not routine or subject to mechanization.
- Qualification for profession requires extensive formal training.
- A specialized organization exists to set: standards, codes and rules of practice. In addition, these organizations define the extent and nature of training to practice in the field.
- A professional makes a commitment to serve the public good.

Examples of other professions:

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Professional Engineering Practice

Canadian Professional Engineering Bodies (Governed by Law):
- APEGBC - Professional Engineers and Geoscientists of BC
- PEO - Professional Engineers Ontario
- OIQ - Ordre des Ingénieurs du Québec
- and others ...

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Professional Engineering Practice

Professional Engineering Bodies govern the practice of engineering on a Provincial basis.

Example, the PEO governs and regulates professional engineering practice through the “Professional Engineers Act” in Ontario.

- standards of knowledge and skill
- standards of practice for the profession
- standards of professional ethics
- promotes public awareness of its role.

Professional Engineering Societies

Professional Engineering Societies/Institutes (non-legal):

- CSME - Canadian Society of Mechanical Engineers

International Professional Engineering Societies/Institutes (non-legal):

- ASME - American Society of Mechanical Engineers
- IEEE - Institute of Electrical and Electronics Engineers
- ASCE - American Society of Civil Engineers
- and others...
Consider a general definition of Ethics:

“The science or doctrine of the sources, principles, sanctions, and ideals of human conduct and character; the science of the morally right.”

Ethical problems occur often in engineering.

Example: An engineer may have to choose between risking the health of workers on a project or stopping the project to install safety equipment, thereby causing delays and increasing costs for the engineer's clients or employers.

At what point does the severity of the risk and potential harm to the workers overcome the real loss to the client or employer that will result if the engineer stops the project to install safety equipment?
As engineers, we must learn to address ethical problems, and come up with the best possible solution.

When an engineer is faced with an ethical problem, there may be several possible solutions, and the goal is to determine the best solution from the ethical standpoint.

This is not always easy, since ethical theories sometimes generate contradictions when applied. Alternative solutions frequently require diametrically opposite actions that are totally incompatible.

This leads to a moral dilemma, which may require breaking one ethical code to satisfy another.

Let's examine four important ethical theories that have evolved over the centuries and develop a methodical approach to solving ethical problems.

Four Ethical Theories:
- Mill's utilitarianism
- Kant's formalism, or duty ethics
- Locke's rights ethics
- Aristotle's virtue ethics
**Ethics in Engineering**

**Mill's utilitarianism**

**Statement:** An action is morally correct if it produces the greatest benefit for the greatest number of persons. The duration, intensity, and equality of distribution of the benefits should be considered.

**Conflict:** A conflict of interest may arise when evaluating the benefits. It is important that a personal benefit must be counted as equal to a similar benefit to someone else.

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**Kant's formalism, or duty ethics**

**Statement:** Each person has a duty to follow those courses of action that would be acceptable as universal principles for everyone to follow.

**Conflict:** Conflicts arise when following a universal principle may cause harm. For example: We know telling a lie is not acceptable. However, what if telling the truth may cause harm?
Ethics in Engineering

 Locke's rights ethics

Statement: All persons are free and equal and each has a right to life, health, liberty, possessions, and the product of his or her labour.

Conflict: It is occasionally difficult to determine when one person's rights infringe on another person's rights.

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Aristotle's virtue ethics

Statement: Happiness is to be achieved by developing "virtues" or qualities of character, through deduction and reason. An act is good if it is in accordance with reason. This usually means a course of action that is the golden mean between extremes of excess and deficiency.

Conflict: The definition of "virtue" is occasionally vague and difficult to apply in specific cases. However, the concept of seeking a "golden mean" between two extremes is frequently useful in ethics.

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Ethics in other Professions

Ethics in Medicine
- Autonomy
- Beneficence (i.e. action in the best interests of patient)
- Non-Maleficence (i.e. Do no harm)
- Informed Consent
- Confidentiality
- Etc. . .

Ethics in Law
- Autonomy
- Confidentiality
- Etc. . .

Ethics in Engineering

A Strategy for Solving Complex Ethical Problems:

Based on the Engineering Design Process:
- Recognize that a problem or need exists
- Gather information and define the Ethical Problem to be solved or goal to be achieved
- Generate alternative solutions or methods to achieve the goal (synthesis)
- Evaluate benefits and costs of alternate solutions (analysis)
- Decision making and optimization (if possible)
- Implement the best solution
Employer Authority and Employee Duties

- Illegal Acts -
- Acts Contrary to the Code of Ethics -
- Acts Contrary to the Conscience of the Engineer

Competence
Negligence
Fraud
Confidentiality and Conflict of Interest

Legal Responsibilities of Engineers

Engineering is considered to be a profession. Like other professions, it is said to be self-regulating. This phrase usually means that the members of the profession act ethically and competently. Professions typically organize associations and societies that, in turn, adopt codes of ethics to govern professional conduct.

Engineers cannot practice their profession without remaining aware at all times of the potential of liability for mistakes in judgement, intentional wrongdoing, or even inadvertent mistakes.

Anytime time a party, including an engineer, enters into a contract, his or her rights and responsibilities are defined with reference to the language of the contract. No one should ever sign a written contract without reading the entire contract and understanding its terms.
Code of Ethics

- All of the major professions in Canada have adopted a code of ethics to provide guidance and support for their profession and its membership.
- These codes deal with common problems like competency, confidentiality, and conflicts of interest and, generally, are more beneficial in the guidance that they provide than they are in a negative, or disciplinary, sense.
- Engineering codes of ethics encourage ethical conduct and provide guidance concerning the obligations of engineers.
- Codes provide support to engineers seeking to act ethically in situations that involve conflict with their superiors and serve as a deterrent to unethical conduct.
- Codes also enhance the profession's public image and generally encourage professionalism.

Duty to the Environment

- The lifestyle of industrialized nations requires high energy usage. The consumption of fossil fuels and the careless disposal of waste products have caused a gradual deterioration in the environment. The deterioration is evident in increased water pollution, acid rain, the greenhouse effect (global warming), and the increasing problem of waste disposal, to mention only a few of the most obvious aspects.

- The question may fairly be asked "What is best for society? Who should take the benefits of new developments and the hazards that accompany them?" The answer has usually been formulated using the utilitarian principle of creating the maximum good for the maximum number of people.
A person's ethical outlook is established at a young age under the influence of family, friends, religious beliefs, elementary schooling, and secondary school teachers. This ethical outlook cannot be changed or influenced significantly at the young adult stage, the university entry age level.

University students can be educated to deal more effectively with ethical dilemmas by being exposed to these situations in a classroom environment where they can be discussed freely with both peers and professors.

Case studies involving situations typical of those encountered by professional engineers in industry, government, and private practice can also be used to demonstrate ethical principles and applicable codes.